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by Herman Frasch, the process involves melting sulfur underground by introducing superheated water through a pipe under pressure and forcing the molten sulfur to the surface by compressed air.

Fraunhofer lines. See spectroscopy.

free energy. An exact thermodynamic quantity used to predict the maximum work obtainable from the spontaneous transformation of a given system. It also provides a criterion for the spontaneity of a transformation or reaction and predicts the greatest extent to which the reaction can occur, i.e., its maximum yield. Transformation of a system can be brought about by either heat or mechanical work. Free energy is derived from the internal energy and entropy of a system in accordance with the laws of thermodynamics.

free radical. A molecular fragment having one or more unpaired electrons, usually short-lived and highly reactive. In formulas, a free radical is conventionally indicated by a dot as Cl^\cdot , $(\text{C}_2\text{H}_5)^\cdot$. In spite of their transitory existence, they are capable of initiating many kinds of chemical reactions by means of a chain mechanism. Free radicals are formed only by the splitting of a molecular bond. A chain can result only if (1) radicals attack the substrate and (2) the radicals lost by this reaction are regenerated. Chain mechanisms for the thermal decomposition of many substances have been established. Free radicals are known to be formed by ionizing radiation and thus play a part in deleterious degradation effects that occur in irradiated tissue. They also act as initiators or intermediates in such basic phenomena as oxidation, combustion, photolysis, and polymerization. See also carbonium ion.

free sulfur. Sulfur which is left chemically uncombined after vulcanization of a rubber compound. When this exceeds 1% the upper limit of solubility of sulfur in rubber, blooming will occur. Most rubber products are vulcanized with as low a sulfur content as possible so that the free sulfur content of the product is seldom over 0.5%.

See also bloom, vulcanization.

freeze-drying. (lyophilization). A method of dehydration or of separating water from biological materials. The material is first frozen and then placed in a high vacuum so that the water (ice) vaporizes in the vacuum (sublimes) without melting and the non-water components are left behind in an undamaged state.

Use: Blood plasma, certain antibiotics, vaccines, hormone preparations, food products such as

coffee and vegetables. One technique prepares freeze-dried ceramic pellets from water solutions of metal salts.

"Freezene"⁴⁵. TM for a series of refrigeration white mineral oils.

Use: Low-temperature lubrication.

freezing point. See melting point.

"Freon"²⁸. TM for a series of fluorocarbon products used in refrigeration and air-conditioning equipment, as blowing agents, fire extinguishing agents, and cleaning fluids and solvents.

Properties: Clear, water-white liquids; vapors have a mild somewhat ethereal odor and are not irritating; essentially stable and inert. Nonflammable, nonexplosive. Noncorrosive. For listing of specific types, see fluorocarbon.

Note: Many types contain chlorine as well as fluorine and should be called chlorofluorocarbons.

"Freon" E.²⁸ TM for a series of hydrogen end-capped tetrafluoroethylene epoxide polymers having a DP up to 10, boiling range 39–490°C, high dielectric constant.

Use: Coolants in electronic devices.

"Freon" C-51-12. See perfluorodimethylcyclobutane.

Freund synthesis. Formation of alicyclic hydrocarbons by the action of sodium (Freund) or zinc (Gustavson) on open chain dihalo compounds; 1,3-dichloropropane derived from the chlorination of propane obtained from natural gas is cyclized in the Hass process by treating with zinc dust in aqueous alcohol in the presence of sodium iodide as catalyst.

"Friante"¹¹⁸. TM for a processed anhydrous potassium aluminum silicate. Typical chemical analysis: Silicon dioxide 74.7%, aluminum oxide 13.7%, potassium oxide 5.6%, other oxides 4.3%.

Properties: Fine, pinkish, inert powder containing no soluble salts. D 2.37, pH 5.4–6.5, bulk d 47 lb/cu ft, free-flowing liquid holding capacity is approximately 1-1/2% max.

Use: Diluent for dry blending or formulating dusting pesticides.

friction. A soft and extremely tacky mixture of rubber and softener applied to a fabric by means of a three-roll calender. The differential speed of the calender rolls drives the material into the interstices of the fabric, forming a strongly adherent coating. Uncured friction on a light sheeting is used for electrical insulating or friction tape.

Common Refrigerants

R-11 Refrigerant - 11

Trichlorofluoromethane CCl_3F

Freon - 11

R-12 Refrigerant - 12

Dichlorodifluoromethane CCl_2F_2

Freon - 12, Genetron - 12, Isotron - 12

Ucon - 12

R-13 Refrigerant - 13

Chlorotrifluoromethane CClF_3

Freon - 13, Genetron - 13, Isotron - 13

R-13B1 Refrigerant - 13B1

Bromotrifluoromethane CBrF_3

Freon - 13B1, Trifluoromethyl

Bromide

70

Common Refrigerants (cont.)

R-14 Refrigerant - 14

Carbon Tetrafluoride CF_4

Freon-14, Tetrafluoromethane

R-21 Refrigerant - 21

Dichlorofluoromethane CHCl_2F

Freon-21

R-22 Refrigerant - 22

Chlorodifluoromethane CHClF_2

Freon-22

R-23 Refrigerant - 23

Trifluoromethane CHF_3

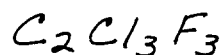
R-31 Refrigerant - 31

Chlorofluoromethane CH_2ClF

Common Refrigerants (cont.)

R-113 Refrigerant - 113

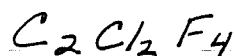
Trichlorotrifluoroethane



Freon - 113

R-114 Refrigerant - 114

Dichlorotetrafluoroethane



Freon - 114, Genetron - 114,

Isotron - 114, Ucon - 114

R-115 Refrigerant - 115

Chloropentafluoroethane C_2ClF_5

Genetron - 115

R-116 Refrigerant - 116

Hexafluoroethane C_2F_6

Freon - 116, Perfluoroethane

Common Refrigerants (cont.)

R-142 Refrigerant - 142

Chlorodifluoroethane $C_2H_3ClF_2$

R-152 Refrigerant - 152

Difluoroethane $C_2H_4F_2$ Genetron - 152, Ethylidene
Fluoride

R-1113 Refrigerant - 1113

Chlorotrifluoroethylene

 C_2ClF_3

Genetron - 1113, CTFE

